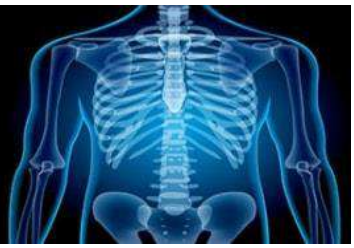
International Journal of Radiology and Diagnostic Imaging



E-ISSN: 2664-4444
P-ISSN: 2664-4436
www.radiologypaper.com
IJRDI 2023; 6(2): 01-06
Received: 01-01-2023
Accepted: 09-02-2023

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Role of MRI imaging in tuberculous and pyogenic spondylodiscitis

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DOI: https://doi.org/10.33545/26644436.2023.v6.i1b.317

Abstract
Background: MRI has advantage in the diagnosis of spinal infections because of its multiplanar capabilities, soft tissue contrast resolution and delineates extent of disease. The purpose of our study is to identify differences in MR imaging between pyogenic and TB Spondylodiscitis.
Methods and Materials: Retrospective analysis of MR Images of 72 patients with confirmed Spondylodiscitis (47 patients with TB Spondylodiscitis and 25 patients with pyogenic Spondylodiscitis). T2, STIR, T1 weighted images (with and without contrast enhancement) were assessed in axial, sagittal and coronal planes. Statistical analysis is by Chi-square test and p value.
Result: The main suggestive findings for TB Spondylodiscitis are
a) Thin and smooth abscess wall (80.9% TB Spondylodiscitis vs. 4% pyogenic Spondylodiscitis).
b) Well defined paraspinal abnormal signal (83% vs. 16%)
c) Heterogeneous and focal enhancement of vertebral body (91.5% vs. 8%)
d) D) Multi segmental involvement (61.7% vs. 38.3%).
The main suggestive findings for Pyogenic Spondylodiscitis are
a) Thick and irregular abscess wall (56% in Pyogenic Spondylodiscitis vs. 4.2% in TB Spondylodiscitis).
b) Ill-defined paraspinal abnormal signal (76% vs. 8.5%)
c) Homogenous and diffuse enhancement of vertebral body (92.0% vs. 8.5%)
d) D) Segmental involvement (68% vs. 38.3%)
e) E) Disc space narrowing (100% vs.74.5%)
Conclusion: Thus MR imaging can differentiate Pyogenic Spondylodiscitis from TB Spondylodiscitis.

Keywords: Spondylodiscitis, magnetic resonance imaging

Introduction
Spondylodiscitis is an infection of the vertebral body and intervertebral disc [1]. It can be categorized as granulomatous (mycobacterial and fungal), pyogenic or parasitic [1]. Spondylodiscitis may lead to severe neurologic deficits and structural deformity [2]. Diagnosis is difficult since infections of the spine may have variable clinical presentations. Since spinal column is near to critical structures accurate and early diagnosis is very important [2].
Spondylodiscitis accounts for 2-7% of all musculoskeletal infections. Hospital mortality rate is around 2% to 17% [3]. TB Spondylodiscitis has to be differentiated from Pyogenic Spondylodiscitis because proper treatment can reduce the disability [4].
Elderly, immunocompromised, chronically debilitated, diabetic patients are more prone to infection [5-8]. Hematogenous spread is most common [7, 8, 9].
Vertebral osteomyelitis was described by Pott as contiguous vertebral destruction (two or more), infection of disc and a paraspinal collection. Typically starts at the anterior vertebral body near to the disco vertebral junction and expands by subligamentous extension and subchondral plate penetration [10].
Pyogenic Spondylodiscitis is usually from hematogenous seeding. The usual causative organism is S. Aureus, but in the presence of spinal implants, coagulase negative staphylococcus infection can also occur [11]. Salmonella, Klebshiella, Serratia are other common organisms. Staphylococcus aureus produces hyalurodinase enzyme which is postulated as a cause for disc lysis [12]. Pyogenic infection almost always starts in the inter vertebral disc and then spreads into end plate and along longitudinal ligaments. Ischemia and necrosis of intervertebral disc occurs with formation of abscess [11].

Significant bone destruction with kyphosis, scoliosis and neurologic compromise is rare when compared to Tb spondylodiscitis [5].

Mycobacterium tuberculosis does not have proteolytic enzymes and spreads slowly with late clinical presentations [5]. Tb spondylodiscitis usually starts in the anterior inferior portion of vertebral body. Then it spreads to body of the vertebra or disc. Central, paradiscal and anterior lesions are common types of vertebral involvement [13]. Vertebral destruction is common and this causes spinal deformity with gibbus. The discs are spared initially (proteolytic enzymes absent), but eventually involved in 75% of cases. Complications such as epidural abscess, arachnoiditis, meningeal and spinal cord infection are more common in Tb spine [14]. Cold abscess formation around vertebral lesions is seen in Tb spondylodiscitis. Retropharyngeal abscess occurs if pus accumulates behind prevertebral fascia in cervical region. Spinal deformity is seen more commonly in spinal Tb than pyogenic vertebral infections. Deformity type depends on vertebral lesion location [13]. Atypical forms of Tb spondylodiscitis are isolated posterior element involvement, skip lesions and solitary vertebral body destruction [15, 16]

Clinically, the symptoms are non specific. The severity of the symptoms depends on infection level, offending pathogen and the response of host [5]. Back pain, raised temperature, local tenderness and increased ESR are common [6, 7, 8, 17].

The detection of infectious spondylodiscitis and its complications depend heavily on imaging. MRI contrast study is the gold standard for spinal infections.MR imaging is very much useful in early stages of infection when other modalities are either normal or nonspecific [5]. MRI contrast study is especially helpful for anatomical localization and early diagnosis of spinal infections [18].

AIM

The purpose of our study is to know differences in MRI imaging between TB Spondylodiscitis and Pyogenic Spondylodiscitis in India where TB is more common.

Materials and methods

Retrospective analysis of MR images of the spine of 72 patients confirmed with infectious Spondylodiscitis at Sri Siddhartha Medical college, Tumkur, India.MRI of these patients was performed between Aug 2020 to Sep 2022.T2, STIR, T1 (with and without contrast enhancement) sequences were assessed in axial, sagittal and coronal planes.

Statistical analysis - Chisquaretest and P value.

Results:

72 cases of confirmed Spondylodiscitis have been included in our study of which 47 were tubercular and 25 were pyogenic.

In our study, 34 patients were less than 50 years and 38 patients were more than 50 years. Mean age of Tb spondylodiscitis cases are 48.7 years. Mean age of pyogenic spondylodiscitis cases are 53.5 years. 29.8% tubercular cases are in the range of 41-50 years. 44% pyogenic cases are in the range of 51-60 years. (P value-0.152, not significant)

In 72 cases, 42 (58.3%) are males and 30 (41.7%) are females. Among 42 males, 25 were of TB cases and 17 were of pyogenic cases. Among 30 females, 22 were tuberculosis and 8 were pyogenic cases. (P value-0.316, not significant)

Lumbar spine is involved in 28 cases (38.9%) of which 15 were of Tb and 13 were of pyogenic cases. Thoracic spine is involved in 18 cases (25%) of which 14 were of Tb and 4 were of pyogenic. Thoracolumbar spine is involved in 11 cases (15.3%) of which 9 were of Tb and 2 were of pyogenic. (P value-0.285, not significant)

35 (48.6%) cases involved 2 vertebra of which 18 were Tb and 17 were Pyogenic Spondylodiscitis. More than 2 vertebra were involved in 37 cases (51.4%), of which 29 were TB and 8 were pyogenic. (P value-0.046, significant)

Skip lesions observed in 9 cases (12.5%) of which 7 were Tb and 2 were Pyogenic Spondylodiscitis. (P value-0.482, not significant)

Disc narrowing is seen in 60 cases (83.3%) of which 74.5% were TB and 25 cases (100%) were Pyogenic Spondylodiscitis. (P value-0.006, significant).

Well defined para spinal abnormal signal was seen in 43 cases (59.7%) of which 39 cases were Tb and 4 were pyogenic. (P value-<0.001, significant).

Ill-defined para spinal abnormal signal seen in 23 cases (31.9%) of which 19 were Pyogenic Spondylodiscitis cases and 4 were tubercular cases. (P value-<0.001, significant)

Grade III or more (>50%) vertebral body destruction was observed in 31.9% cases of Tb Spondylodiscitis and 12% cases of Pyogenic Spondylodiscitis in our study. (P value-0.063, not significant)

T2 hyper intense signal seen in 25 (100%) cases of Pyogenic Spondylodiscitis and 45 (95.7%) cases of TB Spondylodiscitis. (P value-0.296, not significant)

T1 hypo intense signal seen in 24 (96%) cases of Pyogenic Spondylodiscitis and 43 (91.5%) cases of TB Spondylodiscitis. (P value-0.473, not significant)

Epidural extension was observed in 34 cases (47.2%) of which 25 were of Tb cases and 9 were of pyogenic cases. (P value-0.164, not significant)

Thin and smooth abscess wall was observed in 39 cases (54.2%) of which 38 were of Tb and 1 of pyogenic cases. (P value-<0.001, significant)

Thick and irregular abscess wall was observed in 16 cases of which 14 were of pyogenic spondylodiscitis and 2 were of Tb cases. (P value-<0.001, significant).

Spinal compression was observed in 43 cases (59.7%) of which 29 are Tb and 14 are pyogenic cases. (P value-0.801, not significant).

Posterior involvement of spine was involved in 3 cases of Tb spondylodiscitis and 1 case of pyogenic spondylodiscitis. Endplates were involved in all cases of infectious spondylodiscitis.

Discussion

In our study, the sex distribution of infectious Spondylodiscitis is 1.4:1, where as in Ritu Dhawan *et al*. (2015) study [14] it was 1.9:1.There is slight predilection for males in our study.

Thoracic spine was involved in 29.8% of TB Spondylodiscitis and 16% of Pyogenic Spondylodiscitis cases. In Ranjith Kumar *et al*. [19] study 38% of TB Spondylodiscitis and 12.5% of Pyogenic Spondylodiscitis cases involved the thoracic spine. Lumbar spine was involved in 31.9% of Tb Spondylodiscitis and 52% of Pyogenic Spondylodiscitis cases. Where as in Ranjith

Kumar *et al*. [19] study 57% cases of Tb Spondylodiscitis and 87.5% cases of Pyogenic Spondylodiscitis involved the lumbar spine. Overall most common site involved in our study is lumbar spine (38.9%) followed by thoracic spine (25%). In Tb Spondylodiscitis lumbar spine (31.9%) was commonly involved followed by thoracic spine (29.8%) where as in Pyogenic Spondylodiscitis lumbar spine (52%) was commonly involved.

T1 hypo intensity signal was observed in 91.5% of TB and 96% of Pyogenic Spondylodiscitis cases. Where as in Ranjith Kumar *et al*. [19] study 100% of TB and Pyogenic Spondylodiscitis cases showed T1 hypo intensity. In our study T2 hyper intensity signal was observed in 95.7% of TB and 100% of Pyogenic Spondylodiscitis cases. Where as in Ranjith Kumar *et al*. [19] study 95% of TB and 100% of Pyogenic Spondylodiscitis cases showed T2 hyper intensity. There was no significant difference between Tb and pyogenic spondylodiscitis with respect to the involved vertebral bodies signal intensity in our study like previous reports [19, 20].

Paraspinal abnormal signal was well defined and seen in 83% of TB and 16% of Pyogenic Spondylodiscitis cases. Ill-defined paraspinal abnormal signal was seen in 76% of Pyogenic Spondylodiscitis cases and 8.5% of TB cases in our study. Ritu dhawan *et al*. [14] observed well defined paraspinal signal in 80% of Tb and 40% of Pyogenic Spondylodiscitis cases. Chang *et al*. [21] observed ill-defined para spinal signal in 82% of Pyogenic Spondylodiscitis and 18% of Tb cases; well-defined paraspinal abnormal signal in 82% of Tb and 18% of pyogenic cases.

Thin and smooth abscess wall is seen in 80.9% of Tb cases and 4% of Pyogenic Spondylodiscitis cases whereas thick and irregular abscess wall seen in 4.2% of Tb cases and 56% of pyogenic cases in our study. This is corresponding with previous studies [14, 4]. Tb is a disease which has chronic course and relative late phase when compared with pyogenic infections and this may be the cause of well-defined para spinal signal and thin, smooth abscess wall in Tb spondylodiscitis.

Disc narrowing was observed in 74.5% cases of TB Spondylodiscitis and 100% cases of Pyogenic Spondylodiscitis, Where as in Jung *et al*. [4] 55% of Tb and 45% of Pyogenic Spondylodiscitis cases showed disc narrowing. In Mycobacterium proteolytic enzymes are absent and this might be the cause of relative intervertebral disc preservation. Usually, disc will be involved in late phase of Tb Spondylodiscitis.

Two vertebra involved in 38.3% of TB Spondylodiscitis and 68% of Pyogenic Spondylodiscitis cases in our study. More than two vertebras involved in 62.7% of TB Spondylodiscitis and 29% of Pyogenic Spondylodiscitis cases in our study. These findings are in consistent with previous study [22]. Proteolytic enzymes absence is the cause of sub ligamentous spread of infection in Tb spondylodiscitis. Sub ligamentous spread to multiple vertebral bodies is common in TB Spondylodiscitis [22, 23].

Infection spreads from anterior lesion of body of vertebra behind anterior longitudinal ligament to adjacent IV disc and vertebral body.

Homogenous vertebral contrast enhancement was observed in 92% of Pyogenic Spondylodiscitis cases and 8.5% of TB Spondylodiscitis cases in our study. Heterogeneous and focal vertebral contrast enhancement was observed in 91.5% of TB Spondylodiscitis and 8% of Pyogenic Spondylodiscitis cases. This is corresponding with previous reports [21]. This shows that vertebral body damage is severe and permeated in TB Spondylodiscitis. But in Jung *et al*. [4] study there was no significant difference in contrast enhanced pattern.

Grade III or more vertebral body destruction was observed in 31.9% cases of TB Spondylodiscitis and 12% cases of Pyogenic Spondylodiscitis. In Chang *et al*. [21] study 82% of Tb and 30% of Pyogenic Spondylodiscitis cases showed it. It was more in Tb Spondylodiscitis than Pyogenic Spondylodiscitis but not significant.

Skip lesions are seen in 14.9% cases of TB Spondylodiscitis and 8% cases of Pyogenic Spondylodiscitis in our study. Ranjith *et al*. [19] study showed skip lesions in 23.8% of Tb and 12.5% of pyogenic cases. Infection spread by venous plexus may be the cause of skip lesions.

There was no difference in inter vertebral disc signal intensity in Spondylodiscitis in our study like Ritu dhawan *et al*. [14] study.

In our study features suggesting TB Spondylodiscitis which are statistically significant are- para spinal abnormal signal intensity-well defined; abscess wall-thin, smooth; Heterogeneous and focal vertebral enhancement, multi segmental vertebral body involvement, relative disc sparing. These finding are in consistent with previous studies.

Table 1: Distinctive findings of Tuberculous spondylodiscitis in different studies.

Ming Chau-Chang *et al*. (2006) Total-66 cases Tb-33 cases, PS-33 cases	**Jung *et al*. (2004) Total-40 cases. Tb-20 cases, PS-20 cases.**	**Jururat Thammaroj *et al*. (2015) Total-33 cases Tb-24 cases, PS-9 cases**	**Ranjith Kumar *et al*. (2020) Total-30 cases, Tb-21 cases, PS-8 cases, Actinomycosis-1 case**	**Present study Total-72 cases Tb-47 cases, PS-25 cases**
1. ≥ grade III vertebral destruction. 2. Disc destruction-Mild. 3. Post contrast paraspinal abnormal margin- Well defined. 4. Heterogeneous and focal enhancement of vertebral body 5. Vertebral intraosseous abscess with rim enhancement	1. Paraspinal abnormal signal intensity- Well defined. 2. Abscess wall- Thin, smooth. 3. 3.Thoracic spine involvement 4. Paraspinal abscess- Present 5. 5.Multisegmental vertebral involvement.	1. Para spinal soft tissues- Well defined. 2. Abscess wall- Thin, smooth.	1. Well defined para spinal signal 2. Smooth abscess wall. 3. Multi segmental involvement 4. Loss of cortical definition 5. Heterogenous contrast enhancement 6. Grade III vertebral body destruction 7. Disc late involvement	1. Para spinal abnormal signal intensity- Well defined. 2. Abscess wall- Thin, smooth. 3. Heterogeneous and focal vertebral enhancement 4. Multi segmental vertebral body involvement 5. Relative disc sparing

Tb-Tuberculous, PS-Pyogenic spondylodiscitis.

In our study features suggesting Pyogenic Spondylodiscitis which are statistically significant are: Para spinal abnormal signal intensity-Ill defined; abscess wall-thick, irregular; homogenous vertebral enhancement; segmental involvement, disc space narrowing (100%). These findings are in consistent with previous studies.

Table 2: Distinctive findings of Pyogenic spondylodiscitis in different studies.

Ming-Chau Chang *et al.* (2006) Total-66 cases Tb-33 cases, PS-33 cases	**Jung *et al.* (2004) Total-40 cases. Tb-20 cases,PS-20 cases**	**Ritu dhawan *et al.* (2015) Total-50 cases**	**Ranjith Kumar *et al.* (2020) Total-30 cases, Tb-21 cases, PS-8 cases, Actinomycosis-1 case**	**Present study Total-72 cases Tb-47 cases, PS-25 cases**
1. ≤ grade II vertebral destruction. 2. Moderate to complete disc destruction. 3. Ill-defined Para spinal abnormal signal. 4. Disc abscess + peridiscal rim enhancement. 5. Vertebral body enhancement-Homogenous	1. Ill-defined Para spinal abnormal signal. 2. Subligamentous spread (less than 3 vertebral levels). 3. Abscess wall-irregular, thick. 4. 4. Para spinal abscess-Absent.	1. Less than or equal to grade II vertebral destruction. 2. Homogenous enhancement of vertebral body. 3. Ill-defined para spinal signal. 4. Thick and irregular abscess wall. 5. Severe to complete disc destruction	1. Predominent lumbar spine involvement 2. Segmental vertebral involvement 3. Ill-defined para spinal signal intensity. 4. Early involvement of disc. 5. Thick and irregular abscess wall. 6. Homogenous contrast enhancement. 7. 7. Less than grade III vertebral destruction.	1. Paraspinal abnormal signal intensity-ill defined. 2. Abscess wall-irregular, thick. 3. Homogeneous vertebral enhancement 4. Segmental vertebral body involvement. 5. Disc space narrowing (100 vs. 74.5%)

Tb-Tuberculous,PS-Pyogenic spondylodiscitis.

Limitations of the study-We didn't assess diffusion weighted imaging (DWI) in Spondylodiscitis cases. We knew that all Spondylodiscitis cases were either TB Spondylodiscitis or Pyogenic Spondylodiscitis, so sensitivity might have increased for diagnosing. Presenting time may impact the paraspinal abnormal signal margin and abscess wall appearance.

Table 3: Differentiating features between Tuberculous and pyogenic spondylodiscitis in our study.

	Tb spondylodiscitis	**Pyogenic spondylodiscitis**
Paraspinal abnormal signal	Well defined	Ill defined
Contrast enhancement	Heterogenous and focal enhancement of vertebral body	Homogenous enhancement
Wall of Abscess	Thin, smooth	Thick, irregular
Vertebral involvement	Multisegmental	Segmental
Intervertebral disc	Relatively spared	Early involvement

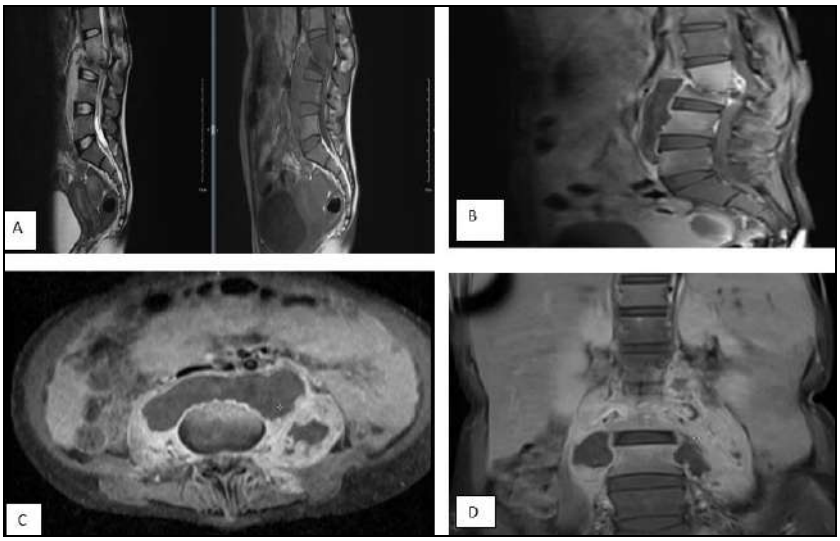

Fig 1: Tb spondylodiscitis: Sagittal T2, T1 (A) and Post contrast T1 sagittal (B) and axial images(C)-T2 hyperintense,TI hypointense(A) irregular destructive lesion and collapsed vertebral bodies with 60% reduction of L3 height noted. There is prevertebral and paravertebral collection with enhancing walls (B, C).Severe compression of spinal cord noted at this level. Bilateral psoas abscess noted (D)

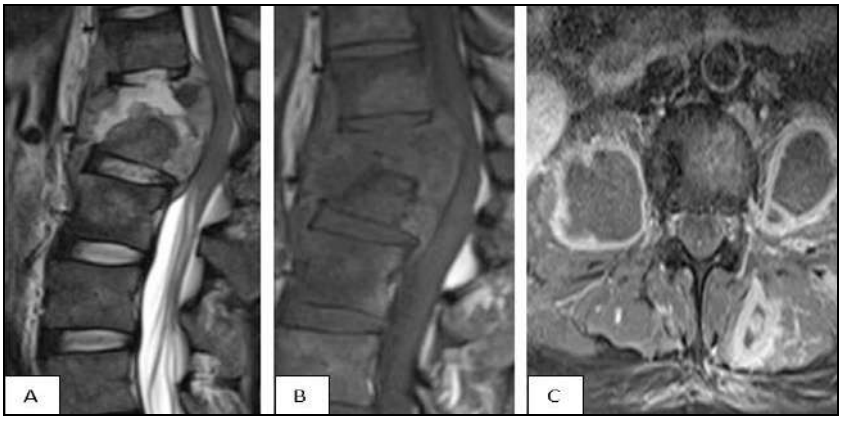

Fig 2: Tb spondylodiscitis: Sagittal T2 (A), T1(B) and Post contrast axial images(C)-T2 hyperintense, TI hypointense irregular destructive lesion and collapsed T12-L1 vertebral bodies with 60% reduction of T12 height noted. There is paravertebral collection with enhancing walls (C).Compression of spinal cord noted at this level

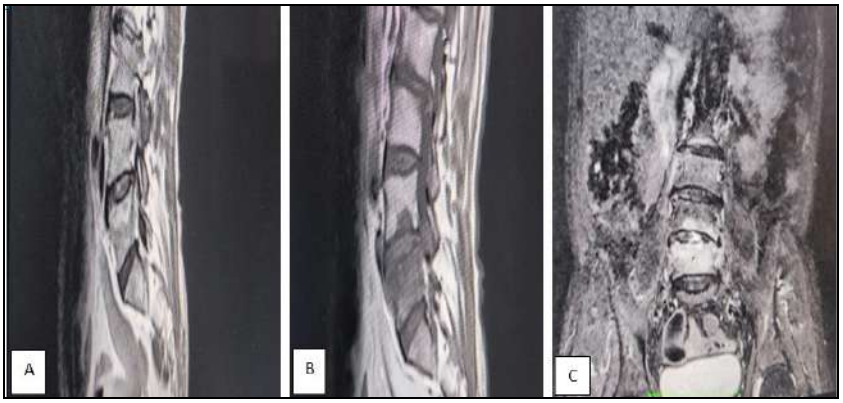

Fig 3: Pyogenic spondylodiscitis: Sagittal T2 (A), T1(B) and STIR images (C)-T2, STIR hyperintense, TI hypointense lesion noted in L4-5 vertebral bodies along with involvement of iv disc

Conclusion

Thus MRI is appropriate modality for differentiating between pyogenic and Tb spondylodiscitis.

Conflict of Interest

Not available

Financial Support

Not available

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How to Cite This Article
Praveen R, Anand SH, Bhanuprakash, Raghu. Role of MRI imaging in tuberculous and pyogenic spondylodiscitis. International Journal of Radiology and Diagnostic Imaging. 2023;6(2):01-06.